Preliminary insights from numerical simulations and observational analysis of precipitating cumulus congestus observed during MC3E

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MC3E cumulus congestus case

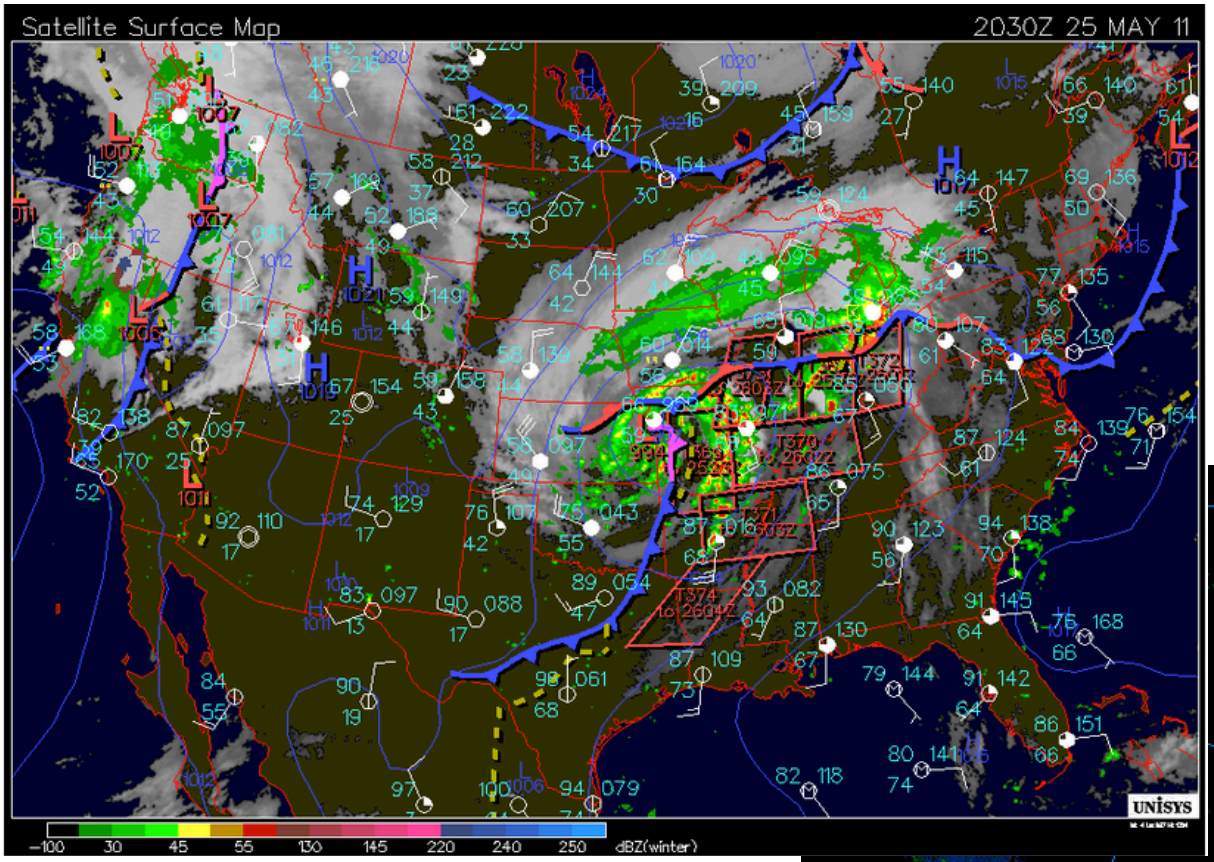
Motivation:

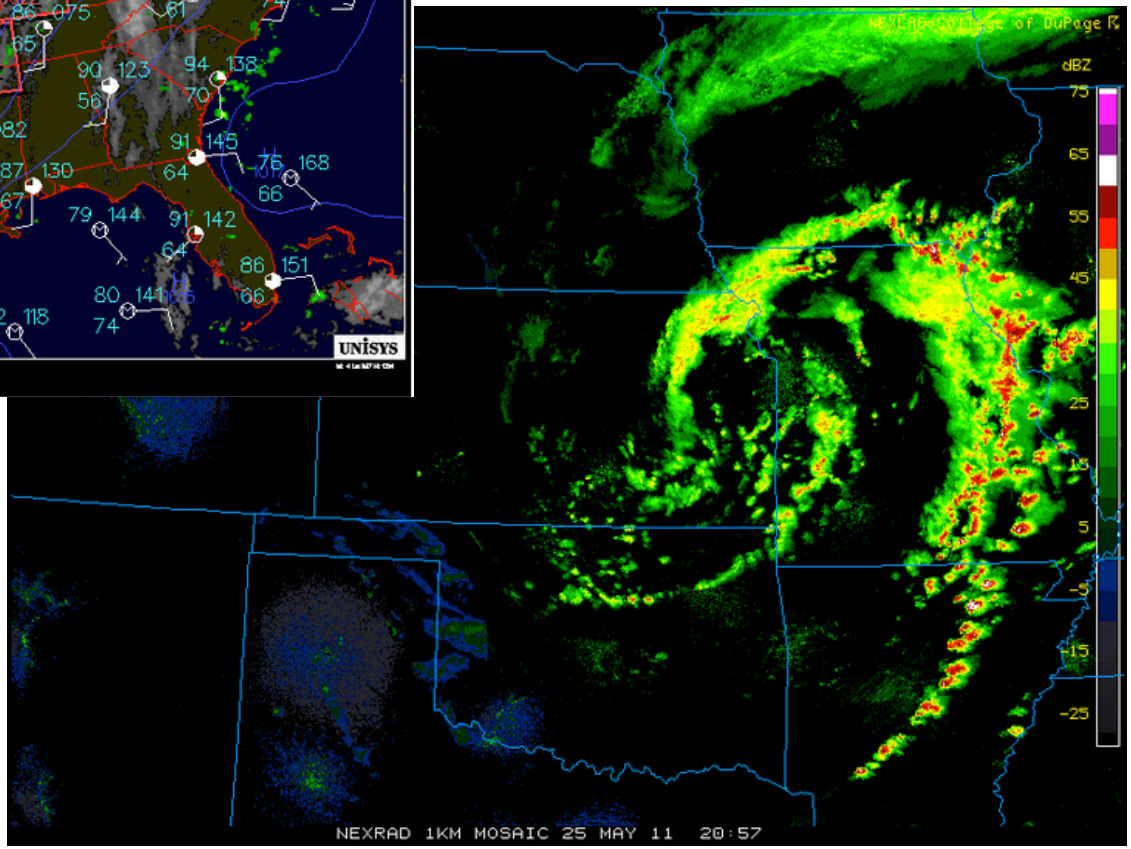
- The recently-deployed ARM radars require innovative approaches to take advantage of their capabilities (high temporal and spatial resolution; spectra)
- LES with bin microphysics is one such approach
- Bring process modelers and observationalists together

Objective:

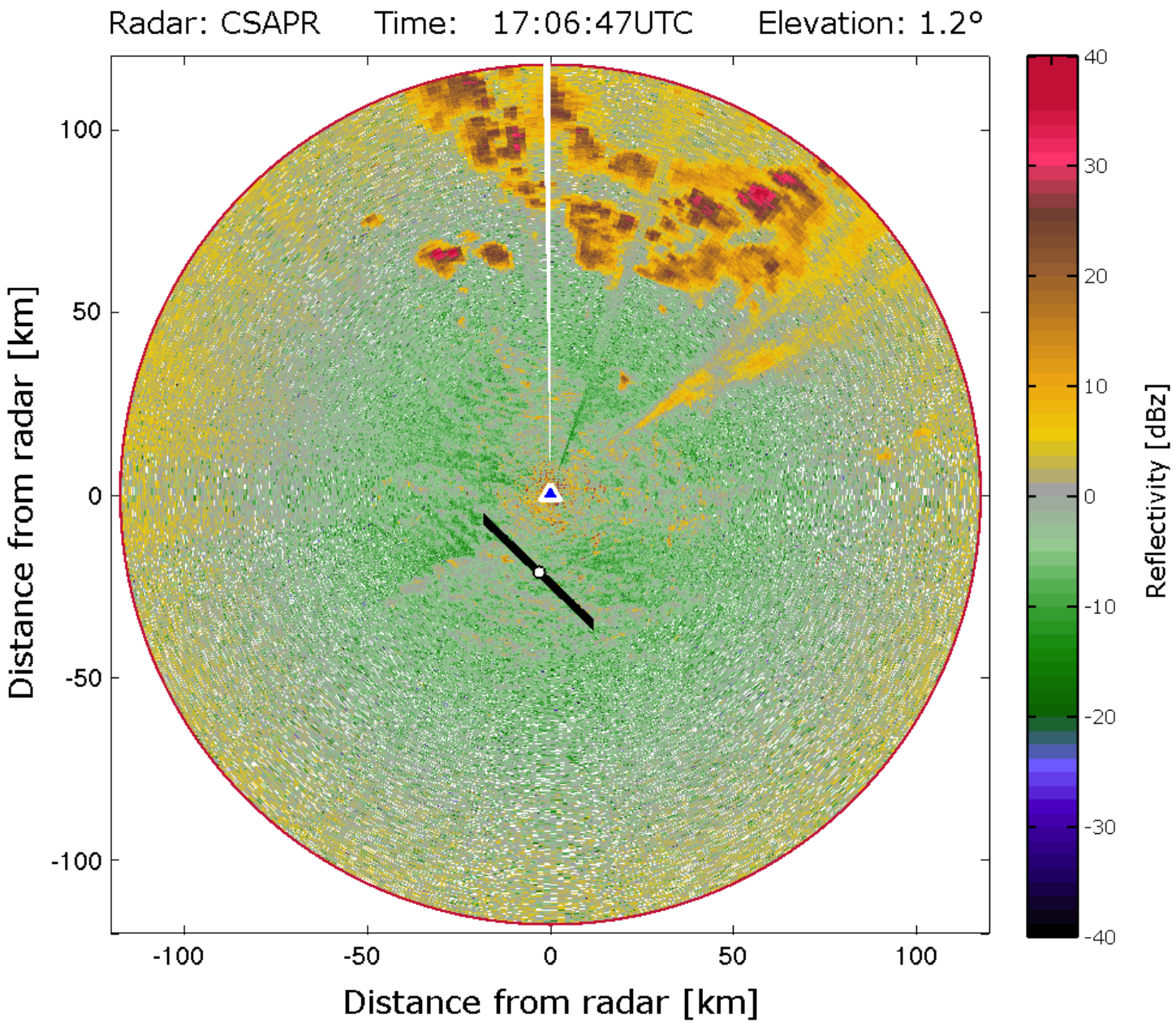
Employ a case of shallow precipitating cloud observed during MC3E to flesh out some of these ideas

MC3E 25 May 2011

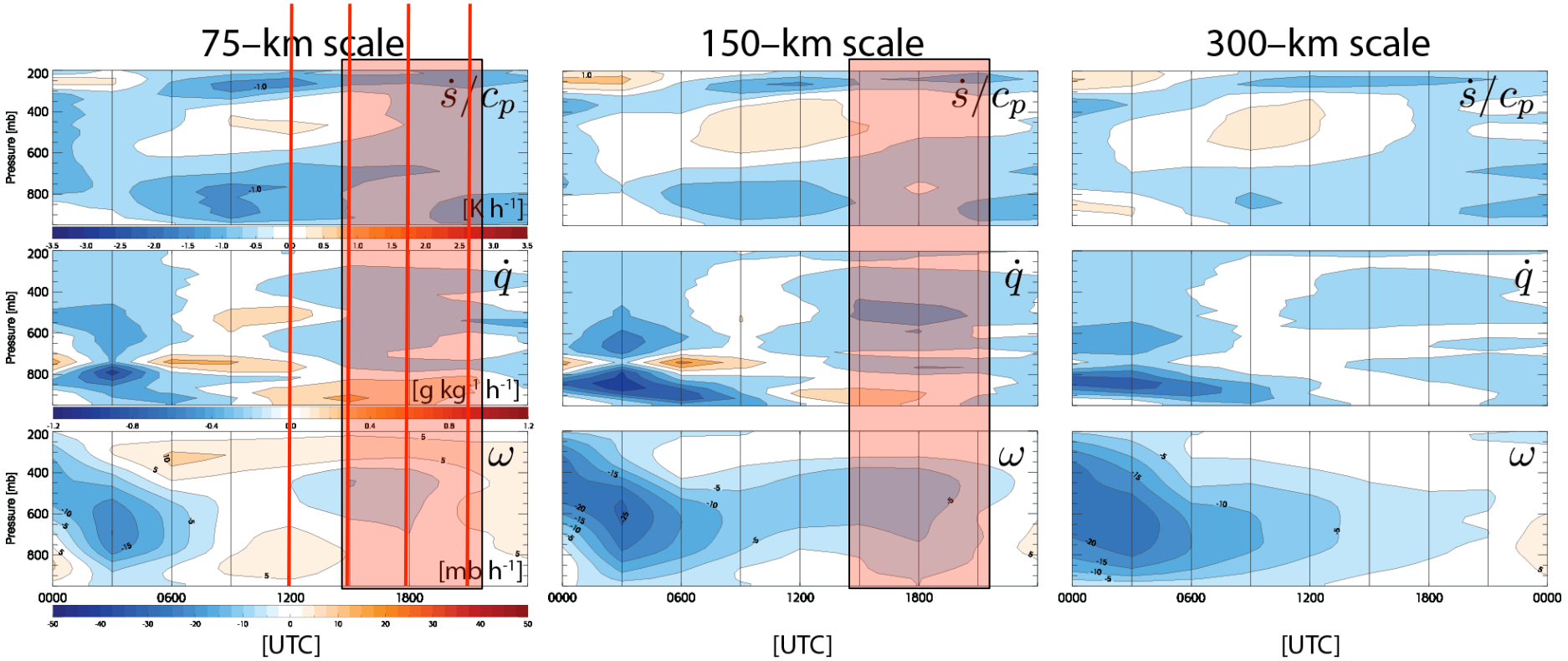




CSAPR view of showery, postfrontal, shallow convection



Tendencies (forcing) from variational analysis



Time-varying forcing

1200 UTC, fixed forcing

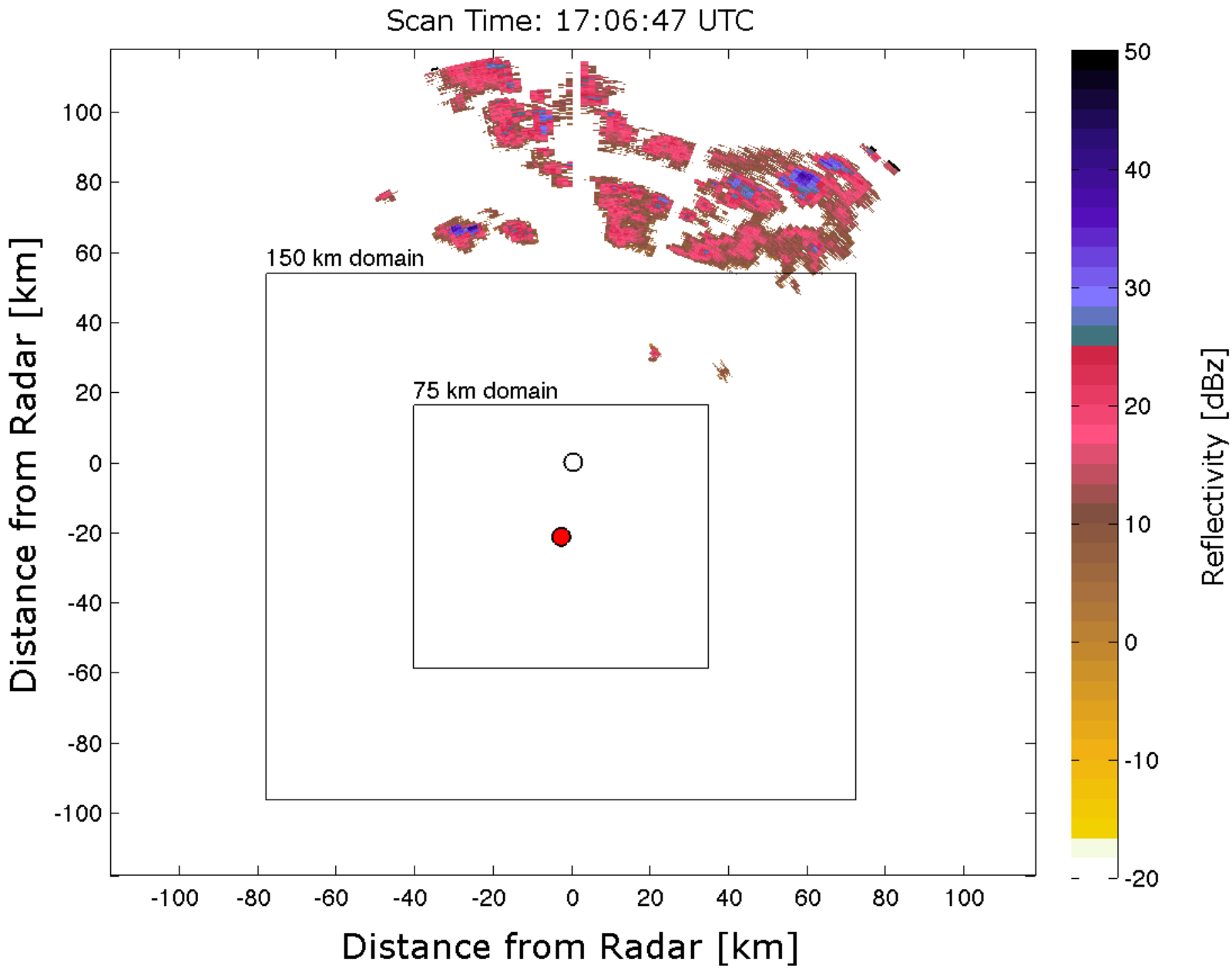
1500 UTC, fixed forcing

1800 UTC, fixed forcing

2100 UTC, fixed forcing

Time-varying forcing, 150-km scale

CSAPR view of showery, postfrontal, shallow convection



LES with size-resolving (bin) microphysics

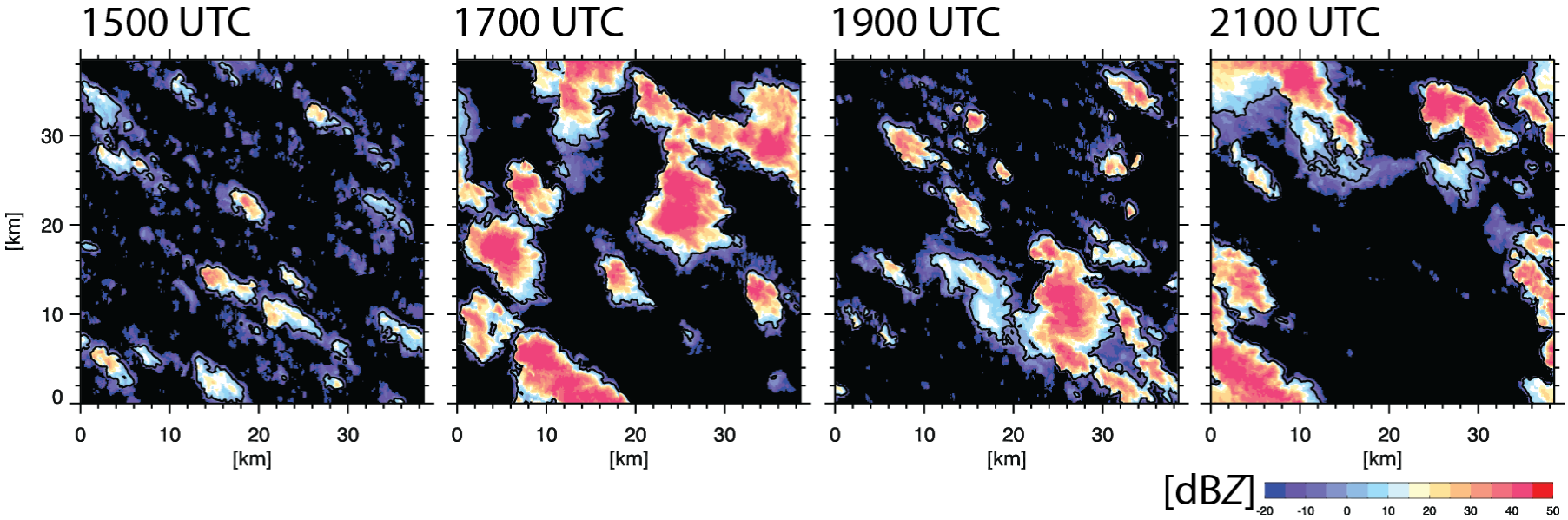
System for Atmospheric Modeling (SAMEX) — Explicit Microphysics; Khairoutdinov and Randall (2003); microphysics based on Kogan (1991)

- MC3E 25 May 2011
- Variational analysis supplies tendencies of temperature and moisture, large-scale vertical motion, and surface fluxes
- Size-resolved ("bin" or "explicit") microphysics
- 34 (36) droplet bins; 19 CCN bins
- Initial CCN ~425/cc
- **Reflectivity calculated directly from DSD**

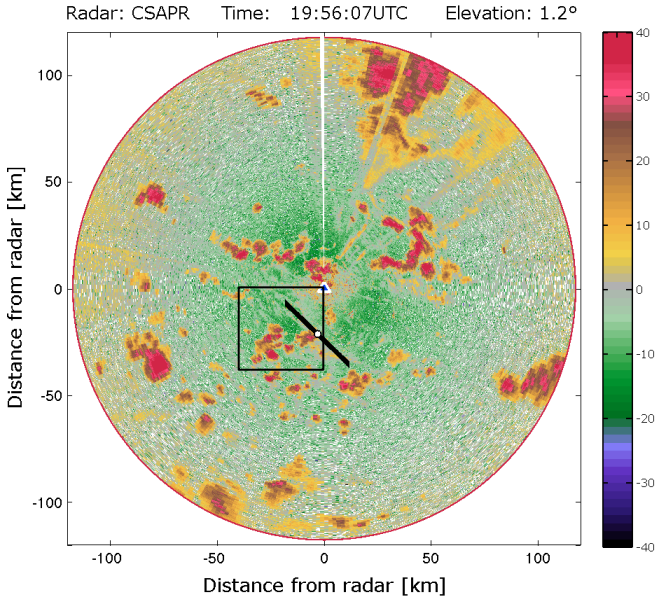
Domain: 38.4 x 38.4 x 8 km^3

- $dx = dy$ =100 m
- dz = 50 m
- Grid: 384x384x160, run for 9 h

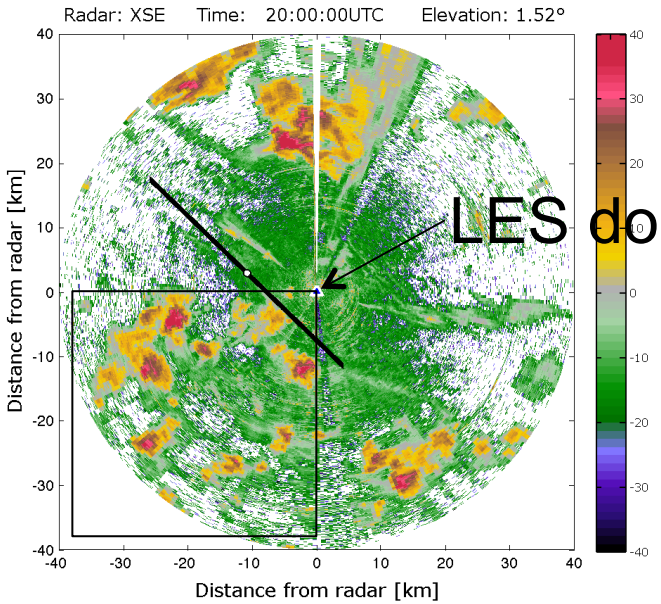
Evolution of simulated reflectivity



CSAPR

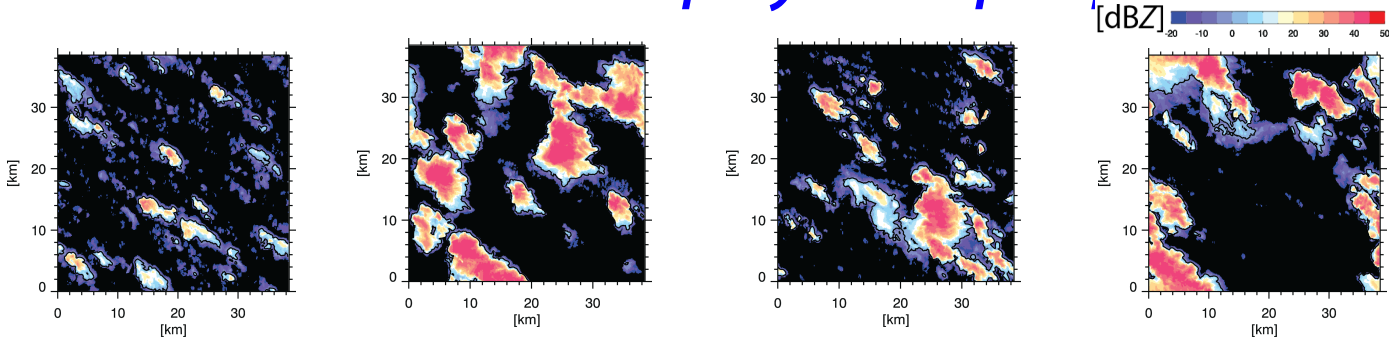


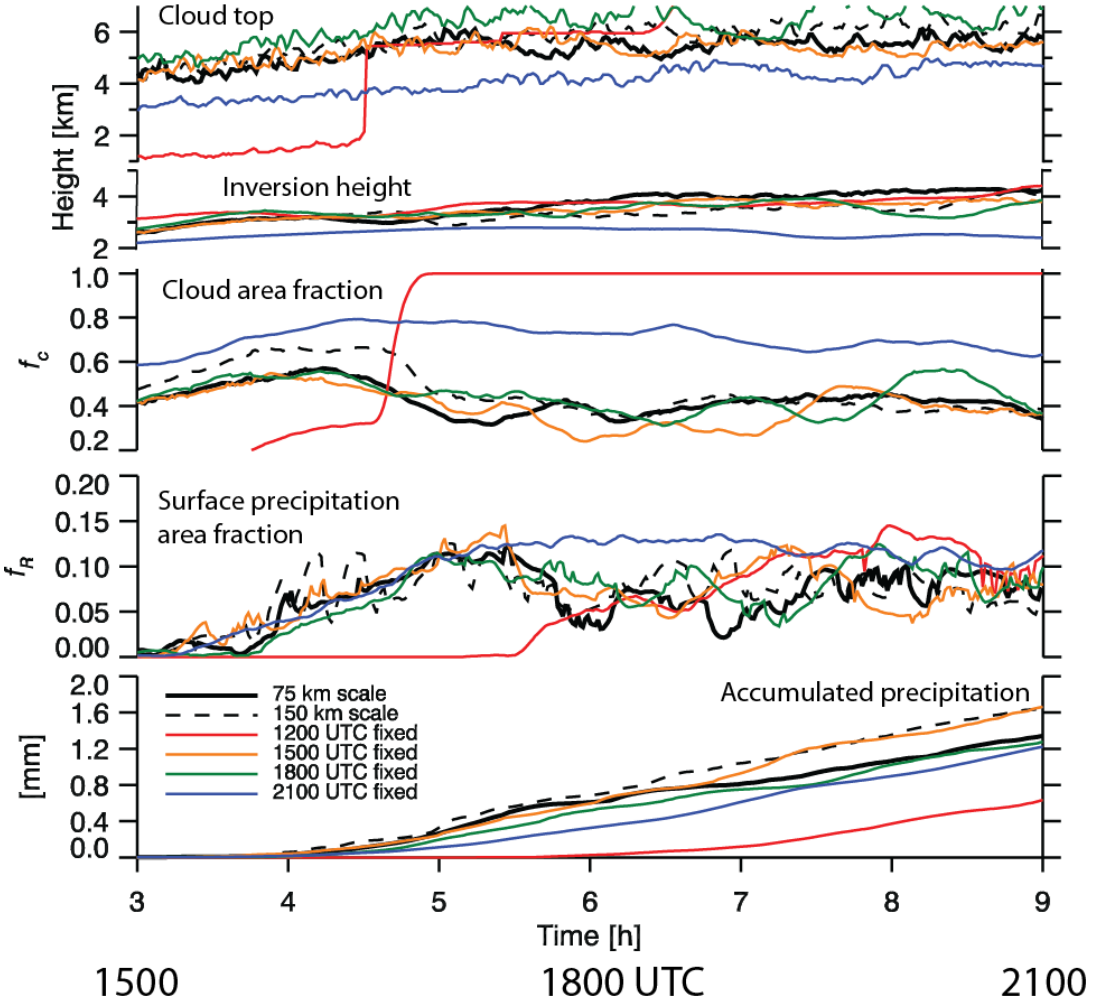
XSAPR

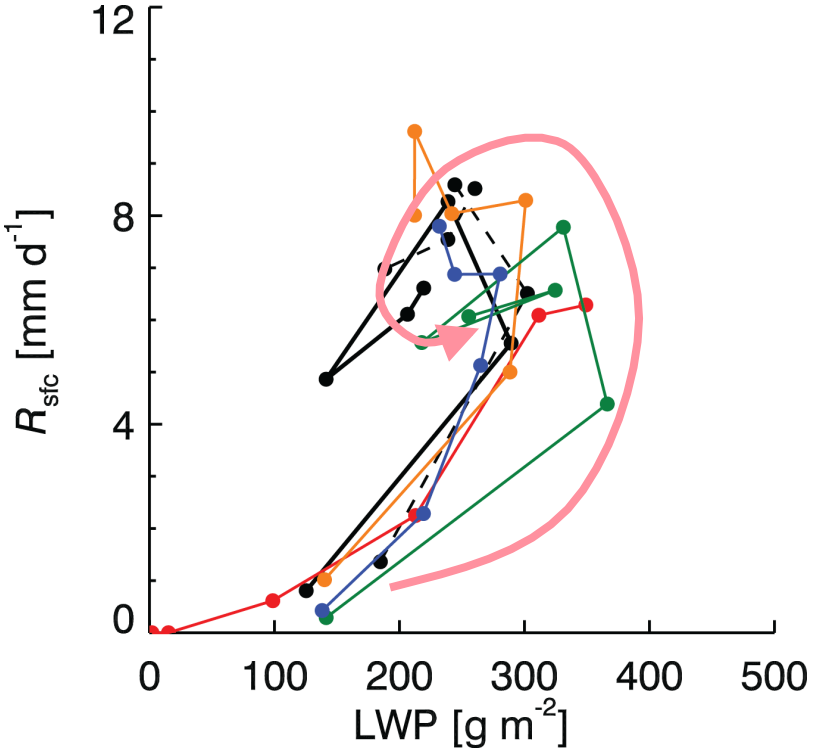


LES domain

Evolution of cloud macrophysical properties

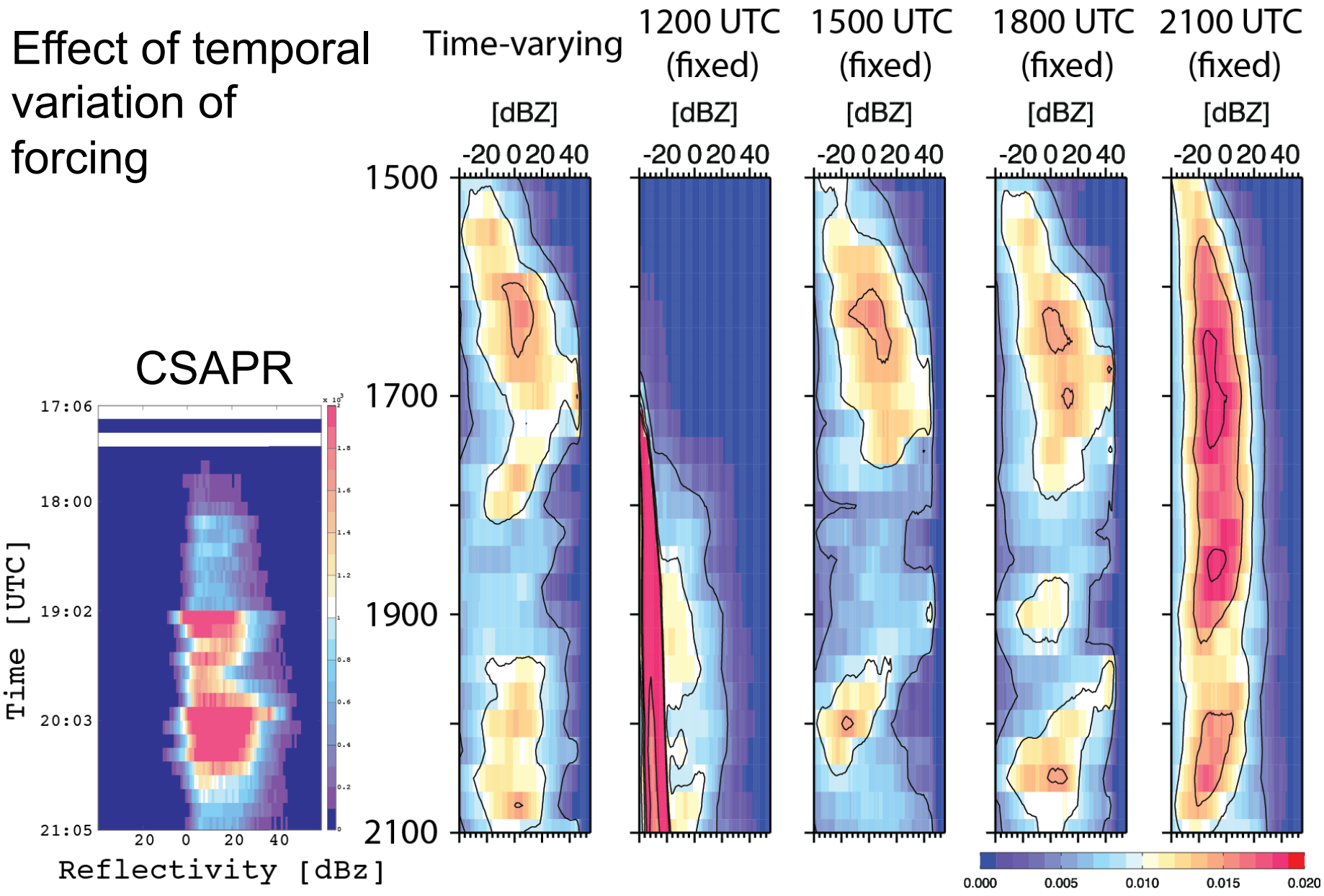






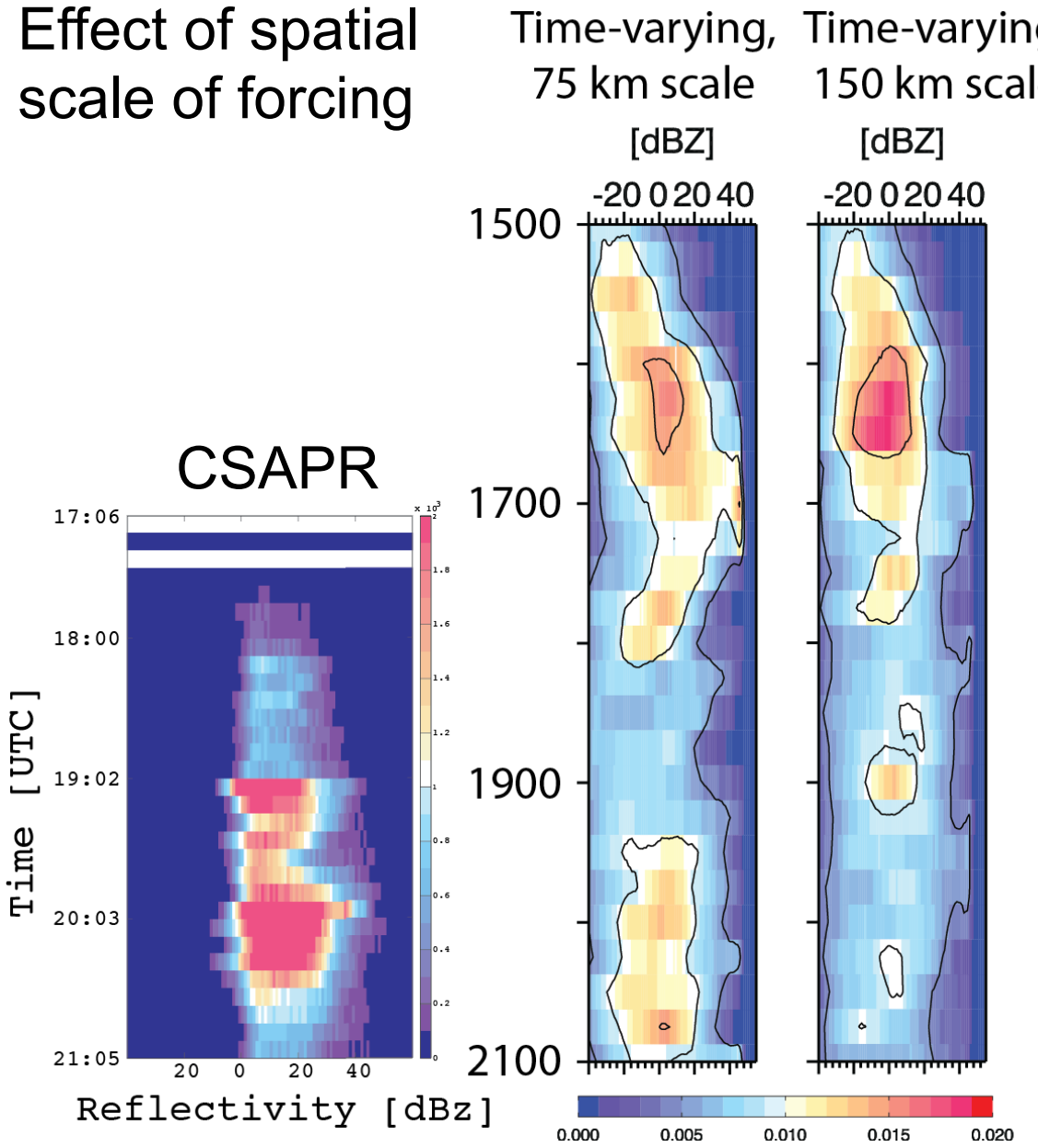
Evolution of reflectivity distribution

Effect of temporal variation of forcing



Evolution of reflectivity distribution — influence of scale

Effect of spatial scale of forcing



Preliminary conclusions

- Evolution of cloud macrophysical properties generally consistent with what would be expected from the forcing
- Cloud field surprisingly resilient to the modest changes in the forcing across the simulations
- Indications of self-limiting precipitation behavior across the simulation suite
- Combination of 3-h forcing interval and idealized model framework may limit how well model results can match observations in rapidly evolving synoptic conditions.